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Research growth and development at Sambalpur University during 2008-2012: a bibliometric analysis

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Abstract: Sambalpur Univesity (SU) was started functioning from 1st January, 1967 in the Odisha State. The university imparting study and research through 27 post-graduate departments in disciplines of Science, Humanities, Business Administration, Social Sciences, Law and Commerce. The present study aims to study the research performance of SU's publications that have been indexed in *Scopus* during 2008 to 2012. The study also identifies the annual growth of university publication, authorship pattern, author productivity, degree of collaboration, length of paper published, most prolific contributor, prolific institution/ organization, geographical distribution etc. Lotka's law of scientific productivity was used to determine the author's productivity and Bradford's is law used to determine scattering of literature in the publication pattern of the university during the period under study.

Keywords: Bibliometrics, *Scopus*, Sambalpur University, Lotka's Law, Bradford's Law, Degree of Collaboration.

Introduction

Bibliometric methods have been used to measure scientific progress in many disciplines of science and engineering and are a common research instrument for systematic analysis (Van Raan, 2005). Since Narin et al. (1976) first proposed the concept of "evaluative bibliometrics", many scientists have tried to evaluate the research trend in the publication outputs of countries, research institutes, journals and subject category (Garcia-Rio et al., 2001; Zhou et al., 2007), the citation analysis (Cole, 1989) and the peak year citation per publication (Chuang et al., 2007; Li and Ho, 2008). Bibliometrics refers to research methodology employed in library and information sciences, which utilizes quantitative analysis and statistics methods to describe distribution patterns of articles with a given topic (Almind and Ingwersen, 1997), field (Campanario et. al., 2006), institute (Moed et. al., 1985) or country (Schubert et al., 1989). These methods have been used to investigate research trends of specific fields recently (Vergidis et. al.,2005; Falagas et. al., 2006; Kumari, 2006).

Objectives

The followings are the key objectives of the present study.

- To measure the research output of the university;
- To identify the most prolific authors during the period;
- To identify the authorship pattern the papers published;

- To identify the journals which were most preferred by the researchers of the university;
- Measure the most cited journals during the period under study;

Literature review

Applying statistical methods over various aspects of LIS papers from Bangladesh Khan, Ahmed, Munshi, and Akhter (1998) found that there is slow growth in literature productivity during 1966-1997. Mittal, Sharma and Singh (2006) examine 536 papers published on LIS education from 1995 to 2004 and found that the growth of literature was negative. Patra, Bhattacharya, and Verma (2006) found that about 4000 authors published 3781 articles, about 0.94 articles per author. Bakri and Willett (2008) in their study to Malaysian Journal of Library and Information Science during 2001- 2006 found that a complete set of 161 articles attracted a total of 87 citation, 52 of which were self-citations. In a bibliometric analysis of *Pakistan Journal of Library and Information Science* Warraich and Ahmed (2011) studied a total of 111 papers which were published during 1995 to 2010, and found that maximum single authored papers were contributed and majority of authors geographically affiliated to Pakistan.

Verma and Tamrakar (2007) in their study of Analysis of Contributions to *Defence Science Journal* found that out of 524 papers 149 (28.43 per cent) were submitted by two authors and High Energy Materials Research Laboratory was the most prolific institution with having 8.96 per cent contributions. In a bibliometric analysis of *DESIDOC Journal of Library and Information Technology* during 2001- 2010, Kumar and Moorthy (2011) found that out of 271 papers 167 papers were published in 6-10 page range and 40.31 per cent citations comprised journals, followed by books with 20.68 per cent. In a bibliometric analysis of diarrhoeal disease research from 1979 to 2009, Khatun and Ahmed found that a total of 1489 authors produced 711 papers with an average of 2.09 authors per paper. Maximum number of (149) papers were published during 2007-2009.

Methodology

The present study covers the research publication of various departments of Sambalpur University which were indexed in *Scopus (officially known as Sciverse Scopus)* during 2008 to 2012. For retrieval of information "Sambalpur University" and "India" were the keywords used as authors affiliation or address and "2008" to "2012" selected as the time span of study. Further, the result was refined to article only. Finally, 301 research papers in different disciplines of science and technology retrieved matched with Sambalpur University as author's affiliation or address. Aspect referring to year wise publication, authorship pattern, favoured journals, most prolific contributor, institution/ organization, geographical distribution etc. were analyzed with MS-Excel.

Analysis and discussion

Annual distribution of publication

Sambalpur University published a total of 301 papers during the period under study which are indexed in Scopus in different fields of science and technology as listed in Table-1, which shows that maximum number of papers published in 2012 i.e. 83 (27.58%) papers,

followed by 2011 (26.91%), 2009 (17.94%), 2010 (14.95%) and 2008 (12.62%) respectively. Further, it shows a negative average growth rate in 2010, and the average annual growth rate percent is 11.29.

Table-1 Annual distribution of publication

Year	No. of publication	Percentage (%)	Annual average growth rate percent (%)
2008	38	12.62	--
2009	54	17.94	29.63
2010	45	14.95	-20
2011	81	26.91	44.45
2012	83	27.58	2.41
Grand Total	301	100	Average 11.29

Period-wise authorship pattern of publication

The period-wise authorship pattern of publication is listed in Table-2, which shows out of 301 papers maximum of 94 (31.23%) contributions have been contributed by three authors, followed by four authors (22.92%), two authors (21.93%) respectively. Again it shows that only 17 (5.65%) papers have been contributed by eight or more than eight authors.

Table-2 Authorship pattern of papers published during 2008-2012

Year	One	Two	Three	Four	Five	Six	Seven	≥Eight	Total
2008	0	9	14	9	2	1	1	2	38 (12.62)
2009	2	6	17	17	5	1	2	4	54 (17.94)
2010	0	14	12	11	1	4	2	1	45 (14.95)
2011	0	17	24	17	6	6	3	8	81 (26.91)
2012	5	20	27	15	9	3	2	2	83 (27.58)
Grand Total	7 (2.33)	66 (21.93)	94 (31.23)	69 (22.92)	23 (7.64)	15 (4.98)	10 (3.32)	17 (5.65)	301 (100)

Note: Figures in parentheses represented percentage.

Author productivity

A total of 554 authors along with 598 authors affiliated to Sambalpur university contributed total 301 papers with 1.99 average authors per paper and 0.51 productivity per author (Table-3). Further, it shows that in 2012 maximum number of 83 papers published and maximum number of 187 authors were affiliated to Sambalpur University.

Table-3 Author productivity

Year	Total no. of papers	Total no. of authors	Total AAPP	Total PPA	Authors only affiliated to SU	AAPP (SU)	PPA (SU)
2008	38	135	3.56	0.29	66	1.74	0.58
2009	54	216	4	0.25	103	1.91	0.53

2010	45	159	3.54	0.29	82	1.83	0.55
2011	81	344	4.25	0.24	160	1.98	0.51
2012	83	298	3.59	0.28	187	2.26	0.45
Total	301	1152	3.83	0.27	598	1.99	0.51

Note: Average Authors Per Paper (AAPP) = Number of authors/ Number of papers.
Productivity per author (PPA) = Number of papers/ Number of authors.

Lotka's law

To determine the author's productivity, Lotka's inverse square law of scientific productivity has been widely used in bibliometric mapping of research output. Lotka's Law describes the frequency of publication by authors in any given field. It states that the number of authors making n contributions is about $1/n^{\alpha}$ of those making one contribution, where α nearly ranges in between 1 to 3. Simply, the number of authors publishing a certain number of articles is a fixed ratio to the number of authors publishing a single article. As the number of articles published increases, authors producing those publications become less frequent. There are 1/4 as many authors publishing two articles within a specified time period as there are single-publication authors, 1/9 as many publishing three articles, 1/16 as many publishing four articles etc. The general formula for calculating is:

$$\mathbf{X^nY=C \text{ or } Y= C/X^n}$$

Where, X= number of publications,
Y= relative frequency of authors with 'X' publications and
C= Constants depending on the specified field.

Putting the value of X= 1 and Y= 7 (Table-4), the calculation obtained was:

1n.7= C
=> 7= C

Putting the value of X= 2 and Y= 66 and C= 7 the calculation obtained was:

2n.66= 7
=> 2n= 7/66
=> n log 2= log 0.11
=> n (0.301)= 0.96
=> n= 0.96/0.301
=> n= 3.19

Table-6 Lotka's law of scientific productivity

No. of papers	No. of authors (observed)	No. of authors (expected with n=2)	No. of authors (expected with n=3)	No. of authors (expected with n=3.19)
1	7	7	7	7
2	66	2	1	1

3	94	1	--	--
4	69	--	--	--
5	23	--	--	--
6	15	--	--	--
7	10	--	--	--
8	10	--	--	--
9	2	--	--	--
10	--	--	--	--
11	--	--	--	--
12	1	--	--	--
13	--	--	--	--
14	2	--	--	--
21	2	--	--	--

Degree of collaboration

Degree of collaboration examines the prominent area of inquiry indicating the trend in patterns of single and joint authors pattern of publication. Table-4 shows the degree of collaboration "C" is 0.98 (which is nearly equals to 1) that means there is few or negligible contributions by single authors during the period under study. Further it shows the degree of collaboration ranges from 0.94 to 1, and there is no single authored paper in 2008, 2010 and 2011.

Table-4 Degree of collaboration

Year	Single authored paper (N_S)	Multiple authored paper (N_M)	N_M+N_S	Degree of Collaboration (C)
2008	--	38	38	1
2009	2	52	54	0.97
2010	--	45	45	1
2011	--	81	81	1
2012	5	78	83	0.94
Total	7	294	301	0.98

Bradford's law and distribution of core journals

Bradford stated that "if scientific journals are arranged in order of decreasing productivity of articles on a given subjects, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucles and succeeding zones will be as $1:n:n^2$…". The journal distribution of Table-5 shows that there was a tremendous scattering of literature in the publication pattern of Sambalpur University. Further, it shows that the first zone or nucleus contains eight journals which covered about one-third of the total papers, followed by second zone with twenty nine accounted for another one-third and the third zone with 148 journals covered the remaining third zone.

Table-5 Ranking of contributing journals published during 2008 to 2012

Rank	Most favored journal for publication	No. of papers	Percentage (%)	Cumulative	
				No. of papers	Percentage (%)
1	Astrophysics and Space Science	12	3.98	12	3.98
2	Journal of the Indian Chemical Society	10	3.32	22	7.3
3	Optics Communications	9	2.99	31	10.29
4	Journal of the Korean Chemical Society	7	2.32	38	12.61
4	Physical Review C - Nuclear Physics	7	2.32	45	14.93
5	Indian Journal of Chemistry - Section A Inorganic, Physical, Theoretical and Analytical Chemistry	6	1.99	51	16.92
5	Indian Journal of Environmental Protection	6	1.99	57	18.91
5	Plant Science	6	1.99	63	20.9
6	International Journal of Theoretical Physics	5	1.66	68	22.56
7	International Journal of Modern Physics E	4	1.33	72	23.89
7	Journal of Colloid and Interface Science	4	1.33	76	25.22
7	Journal of the Institution of Engineers (India): Electrical Engineering Division	4	1.33	80	26.55
7	Polymer Composites	4	1.33	84	27.88
8	Applied Mathematical Sciences	3	1	87	28.88
8	Energy and Fuels	3	1	90	29.88
8	Indian Journal of Biotechnology	3	1	93	30.88
8	International Journal of Modern Physics B	3	1	96	31.88
8	Journal of Dispersion Science and Technology	3	1	99	32.88
8	Journal of Physics G: Nuclear and Particle Physics	3	1	102	33.88
8	Letters in Drug Design and Discovery	3	1	105	34.88
8	Library Philosophy and Practice	3	1	108	35.88
9	29 Journals with 2 papers	58	19.27	166	55.15
10	135 journals with single paper	135	44.85	301	100
Grand Total		301	100	--	--

Figure-2 provides a brief sketch of Bradford's distribution of core journals on publication pattern of Sambalpur University during 2008 to 2012. A total of 185 journals presented by 301 papers., out of which only two journals published more than 10 papers; 6 journals published 6 to

9 papers; thirteen journals published 3 to 5 papers; 29 journals published 2 papers and remaining 135 papers were scattered among 135 journals 9Table-6). Bradford's distribution, core journals are those that lay on the initial curved part of the *"S"* shaped plot until it tangentially becomes a straight line. Here, in figure-2, the slope of the curve also decreases slightly after the journal Plant Science (8^{th}) journal, so these journals may be regarded as the core journals on the research publication of Sambalpur University during 2008 to 2012.

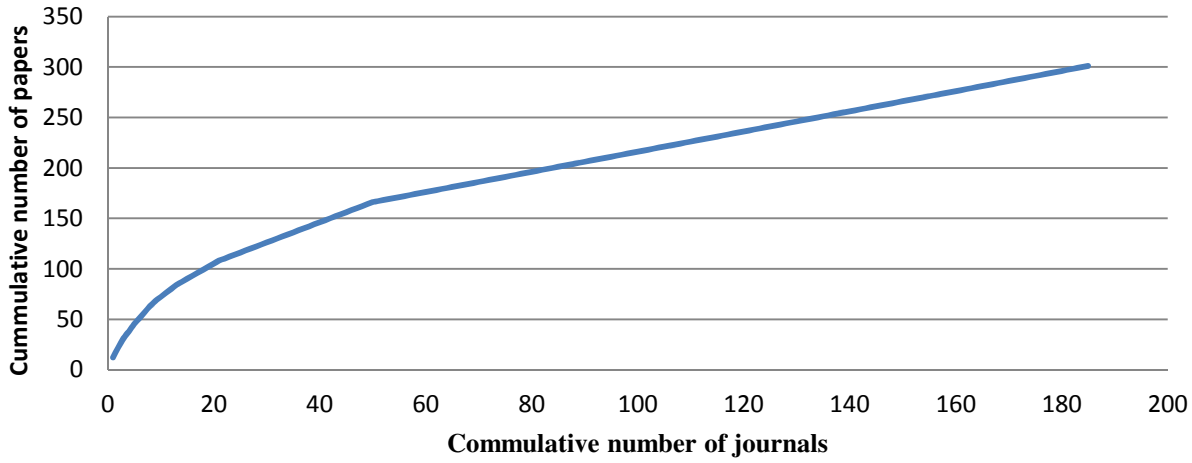

Fig.-1 Bradford's distribution

Length of paper published

Table-6 gives a detailed overview of published papers page length, which shows that more than half of papers are in between 6-10 pages in length i.e. 165 (54.82%) papers, which is followed by 62 (20.6%) papers in between 1-5 pages, 54 (17.94%) papers in between 11-15 pages respectively. Again it shows only 2 (0.66%) papers are in published with 26 or more than 26 pages in length.

Table-6 Length of paper published during 2007-2011

Page range	1-5	6-10	11-15	16-20	21-25	≥26	Total
2008	15	20	3	0	0	0	38 (12.62)
2009	10	29	12	1	2	0	54 (17.94)
2010	7	26	8	2	2	0	45 (14.95)
2011	20	40	15	4	1	1	81 (26.91)
2012	10	50	16	6	0	1	83 (27.58)
Grand Total	62 (20.6)	165 (54.82)	54 (17.94)	13 (4.32)	5 (1.66)	2 (0.66)	301 (100)

Most prolific institution/ organizations

Out of 301 (100%) papers the contributors affiliated to Veer Surendra Sai University of Technology, Odisha were the most prolific contributor after Sambalpur University with having

38 (12.63%) contributions followed by National Institute of Technology, Rourkela with 10.64% contributions (Table-7). IIT Kharagpur, Institute of Physics, Bhubaneswar and Kanak Manjari Institute of Pharmaceutical Sciences stood at 4th, 5th and 6th rank respectively.

Table-7 Most prolific institution/ organization

Sl. No.	Name of the institute/ Organization	No. of contributions	Percentage (%)
1	Sambalpur University, Sambalpur	301	100
2	Veer Surendra Sai University of Technology, Odisha	38	12.63
3	National Institute of Technology Rourkela, Odisha	32	10.64
4	Indian Institute of Technology, Kharagpur	16	5.32
5	Institute of Physics, Bhubaneswar	14	4.66
6	Kanak Manjari Institute of Pharmaceutical Sciences	11	3.66
7	Birla College of Arts, Science & Commerce	10	3.33
8	Sundargarh Engineering College, Odisha	9	2.99
9	North Orissa University, Odisha	8	2.66
9	Panjab University, Punjab	8	2.66
10	Hope College	7	2.33
10	Tripura University, Tripura	7	2.33
10	Institute of Minerals and Materials Technology, India	7	2.33
10	Hiroshima University	7	2.33

Prolific author during 2008-2012

Table- shows top-10 most prolific contributor during the period under study, B.K. Mishra is the most prolific contributor with 33 contributions followed by P. Nayak (5.65%), H.N. Pati and P.K. Behera with 4.66% contributions stood with 3rd rank. S.P. Pati, D.C. Dash, P.K. Mohapatra, T.R. Routray, R.K. Mohapatra and S. Patel with 13 (4.32%) contributions stood at the 4th rank.

Table-8 Most prolific contributor

Rank	Name of the contributor	No. of contributions	Percentage (%)
1	Mishra, B.K.	33	10.97
2	Nayak, P.	17	5.65
3	Pati, H.N.	14	4.66
3	Behera, P.K.	14	4.66
4	Pati, S.P.	13	4.32
4	Dash, D.C.	13	4.32
4	Mohapatra, P.K.	13	4.32
4	Routray, T.R.	13	4.32
4	Mohapatra, R.K.	13	4.32
4	Patel, S.	13	4.32

5	Tripathy, S.K.	12	3.99
6	Patra, S.K.	11	3.66
6	Behera, B.	11	3.66
6	Sahoo, S.	11	3.66
7	Misra, P.K.	10	3.33
8	Choudhary, R.N.P.	9	2.99
8	Swain, S.K.	9	2.99
8	Panda, K.C.	9	2.99
8	Dash, S.	9	2.99
9	Panigrahi, S.	7	2.33
10	Behera, A.K.	6	1.99
10	Sahu, S.	6	1.99
10	Biswal, B.	6	1.99

Subject-wise rank distribution of publication

Table-9 provides major subject areas, which shows Physics and Astronomy is the most favoured research area among the research community of the Sambalpur University with 29.91%, followed by Chemistry (25.25%), Materials Science (21.93%), Engineering (16.95%) respectively. Biochemistry, Genetics and Molecular Biology, Pharmacology, Toxicology and Pharmaceutics, Agricultural and Biological Sciences with 13.62%, 10.29%, 9.31% stood at the 5^{th}, 6^{th} and 7^{th} rank respectively.

Table-9 Major research areas

Rank	Major subject areas	No. of papers	Percentage (%)
1	Physics and Astronomy	90	29.91
2	Chemistry	76	25.25
3	Materials Science	66	21.93
4	Engineering	51	16.95
5	Biochemistry, Genetics and Molecular Biology	41	13.62
6	Pharmacology, Toxicology and Pharmaceutics	31	10.29
7	Agricultural and Biological Sciences	28	9.31
8	Chemical Engineering	27	8.98
9	Earth and Planetary Sciences	24	7.98
10	Social Sciences	22	7.31
11	Mathematics	21	6.98
12	Environmental Science	17	5.65
13	Computer Science	14	4.66
14	Medicine	11	3.66
15	Energy	8	2.66
16	Arts and Humanities	5	1.67
17	Immunology and Microbiology	4	1.33

18	Multidisciplinary	3	0.99
19	Business, Management and Accounting	2	0.67
20	Health Professions	1	0.34
20	Veterinary	1	0.34
20	Economics, Econometrics and Finance	1	0.34

Geographical distribution of publication during 2008-2012

Geographical distribution of papers listed in Table-10, on the whole a total of 301 contributors belonging to Sambalpur University (India) and the collaborative contributors were from United States (4.99%), Japan (2.33%), Egypt (1.67%). Australia, France, Singapore, Turkey with 0.67% contributors stood at 5th rank. Again it shows that all the 1152 contributors are scattered among 12 countries.

Table-10 Geographical distribution of publication

Rank	Name of the country	No. of contributions (N= 301)	Percentage (%)
1	India	301	100
2	United States	15	4.99
3	Japan	7	2.33
4	Egypt	5	1.67
5	Austria	2	0.67
5	France	2	0.67
5	Singapore	2	0.67
5	Turkey	2	0.67
6	Mexico	1	0.39
6	Canada	1	0.39
6	Bangladesh	1	0.39
6	South Korea	1	0.39

Findings/ Conclusion

The followings are the key findings of the present study:

1. The university's publication range ranges from 38 to 83 papers with an annual average growth rate percent of 11.29 papers.
2. Maximum number of three authored (31.23%) papers published which is followed by four authors (22.92%), eight or more than eight authors contributed a total of 17 (5.65%) papers.
3. A total of 1152 authors contributed 301 papers out of which 598 authors were affiliated to Sambalpur University.
4. Astrophysics and Space Science is the most favoured journal for publication among the researchers of the university with 12 (3.98%) papers, followed by Journal of the Indian Chemical Society with 10 (3.32%) papers. Further it has been observed that 29 journals contains 2 papers and 135 journals contain only one paper during the period under study.

5. Veer Surendra sai University of Technology was the second most prolific institution/ organization followed by NIT, Rourkela and IIT, Kharagpur etc.
6. B.K. Mishra with 33 contribution stood at the first position. P. Nayak with17, H.N. Pati and P.K. Behera with 14 contributions stood with second and third positions respectively.
7. Physics and Astronomy was the most favoured research area followed by Chemistry, materials Science, Engineering, Biochemistry, Genetics and Molecular Biology etc.
8. All the 1152 contributors were scattered among Indian with 11 foreign countries.
9. Lotka's law of scientific productivity, it is observed that the authors contribution pattern to the research output of Sambalpur University researcher during the period under study is far away, because the 'observed' authors and their respective productivity frequency differs 'expected' frequency of authors and their productivity.

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